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The foraminifera associated with the alga *Gelidium pristoides*, South Africa

by

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ABSTRACT

The foraminiferal fauna associated with the alga *Gelidium pristoides* was examined. Algal samples were collected at the same tidal level from 13 rocky shores in the distribution range of *G. pristoides*. Forty six species of foraminifera were identified, nine of which may be new species. The species composition was typical of the intertidal environment and the most dominant species were typically phytal. The study was the first conducted on Recent intertidal foraminifera in South Africa.

KEY WORDS: Foraminifera, *Gelidium pristoides*, False Bay, intertidal, rocky shores, Recent, South Africa.

INTRODUCTION

The earliest studies on extant South African foraminifera were conducted by Ehrenberg (1845, 1863), Brady (1884), Murray (1889) and Pearcey (1908). Recent and late Quaternary South African foraminifera have been studied during biological and geological surveys (Chapman 1924; Martin 1974, 1981) and mineralogical explorations (McMillan 1987*a*, *b*, 1990*a*, *b*; Dale & McMillan 1998, 1999). Most studies have been of a geological nature (Chapman 1923; Smitter 1956; Parr 1958; Albani 1965; Cooper & McMillan 1987; Wright *et al.* 1990; Acheson *et al.* 1999), and do not present taxonomic descriptions of collected material. This lack of clear descriptions limits accessibility of the fauna to study and precludes any understanding of the diversity of recent foraminifera around South Africa.

This contribution attempts to add to the presently available information regarding regional extant foraminifera and provides descriptions of all 'new' species encountered during a survey of phytal fauna around the Cape Peninsula and southern Cape coast (Toefy *et al.* 2003).

MATERIAL AND METHODS

All material was collected from *Gelidium pristoides* at a variety of locations around South Africa (Fig. 1). Full details concerning the collection of samples are provided by Toefy *et al.* (2003). The format of the descriptions follows the literature. All specimens were observed and photographed under the Scanning Electron Microscope. Only restricted synonymies are provided; fuller synonymies can be found in the selected references (underlined). The geographic distributions of species were obtained from the selected references. Remarks have not been written for recognised species, and they have been confined to those that are not known, or which differed slightly from previous descriptions. Measurements given are of the maximum width and the maximum height. All material is deposited at the South African Museum, Cape Town, and reference numbers are provided (as Stub Numbers). The following is a list of species found and their classification (following Loeblich & Tappan 1988).

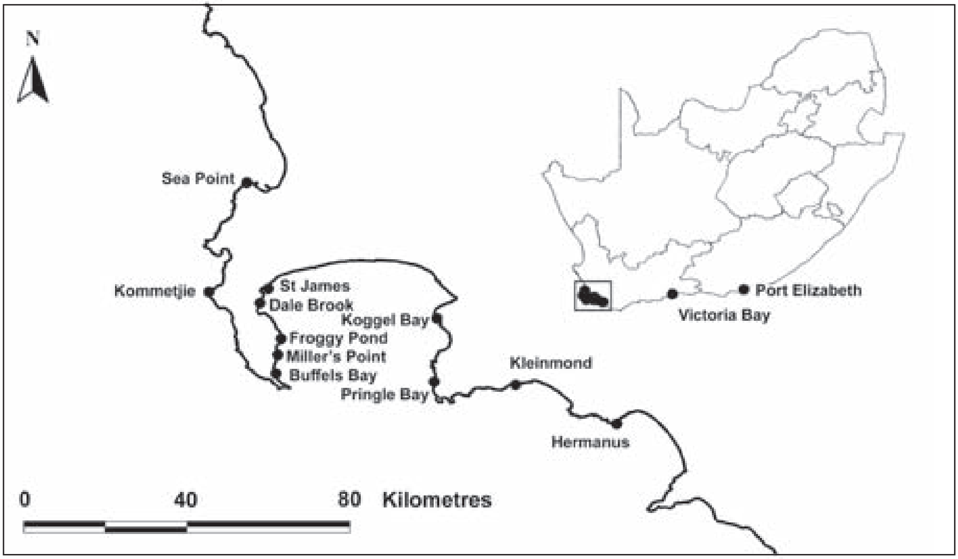
N
Sea Point
Kommetjie
St James
Dale Brook
Koggel Bay
Froggy Pond
Miller's Point
Buffels Bay
Pringle Bay
Kleinmond
Hermanus
Port Elizabeth
Victoria Bay
0
40
80 Kilometres

Fig. 1. Map illustrating the rocky shores sampled around South Africa.

TAXONOMY

Phylum Foraminifera Eichwald, 1830
Family Rhabdamminidae Brady, 1884
Subfamily Rhabdammininae Brady, 1884
Marsipella Norman, 1878
Marsipella sp. "A"

Fig. 2A

Marsipella: Loeblich & Tappan 1988: 23, pl. 15, fig. 2.

Description: Small elongated test. One long tubular chamber. Wall composed of large sand grains. Exterior coarse. May be open on both ends or one end may be closed by aggregation of sand grains. Slightly twisted at final chambers. No visible sutures. Width = 92.3 µm, height = 323.07 µm, width:height = 0.29:1.

Material examined: A27391.

Distribution: Cosmopolitan. Around South Africa recorded at Sea Point and Kommetjie.

Remarks: This genus is particularly difficult to classify. The species may be regarded as *Marsipella* aggregate. However, the size of the species described here is much larger than the type specimen described by Norman (1878). Not many of these specimens were found, therefore, it was difficult to make a conclusive classification.

Family Trochamminidae Schwager, 1877
Trochammina Parker & Jones, 1859
Trochammina squamata Jones & Parker, 1860

Fig. 2B

Trochammina squamata: Jones & Parker 1860: 304; Heron-Allen & Earland 1915: 619; 1930: 70; Parker 1952: 70, pl. 4, figs 11, 12; Boltovskoy 1963: 64, pl. 7, fig. 20; Hedley *et al*. 1964: 164, figs 1–3.

Material examined: A27392.

TABLE 1

The species are listed in systematic order and their occurrence at each station is noted. SP - Sea Point, KO - Kommetjie, BB - Buffels Bay, SJ - St James, MP - Miller's Point, FP - Froggy Pond, DB - Dale Brook, KB - Koggel Bay, PB - Pringle Bay, KM - Kleinmond, H - Hermanus, VB - Victoria Bay, PE - Port Elizabeth.

Species	SP	KO	BB	SJ	MP	FP	DB	KB	PB	KM	H	VB	PE
Marsipella sp. "A"	X	X											
Trochammina squamata	X												
Quinqueloculina dunkerquiana	X	X	X	X	X	X	X	X	X	X	X	X	X
Quinqueloculina seminulum	X	X	X	X	X	X	X	X	X	X	X	X	X
Quinqueloculina triangularis	X												
Quinqueloculina undulata	X			X	X	X	X			X			
Quinqueloculina vulgaris				X	X	X	X	X		X			
Quinqueloculina sp. "A"	X												
Triloculina trigonula			X	X				X	X			X	X
Miliolinella subrotundata	X	X	X	X	X	X	X	X	X	X	X	X	X
Lagena semilineata		X		X	X						X		
Lagena sulcata	X	X		X	X						X		
Lagena tenuis	X	X	X				X				X		
Lagenosolenia sp. "A"			X	X	X	X	X					X	
Oolina sp. "A"	X	X	X	X	X	X	X		X	X	X		X
Oolina melo	X		X	X				X	X		X		
Oolina squamosulcata			X	X				X	X				
Fissurina marginata	X	X		X	X	X	X	X	X	X	X	X	X
Fissurina sp. "A"			X	X				X	X	X	X	X	X
Guttulina irregularis	X												
Glandulina sp. "A"	X	X	X	X									X
Bolivina "*fossa*"	X	X	X	X	X	X	X	X	X	X	X	X	X
Bolivina pseudoplicata	X	X	X	X	X	X	X	X	X	X	X	X	X
Bolivina sp. "A"	X												
Brizalina pseudopunctata	X	X	X	X	X	X	X	X	X	X	X	X	X
Brizalina "*rocklandsensis*"				X	X	X			X	X			X
Bulimina elongata	X	X	X	X	X	X	X	X	X	X	X	X	X
Trifarina angulosa	X												
Neoconcorbina sp. "A"				X					X	X			X
Rosalina cf. *globularis*	X	X	X	X	X	X	X	X	X	X	X	X	X
Rosalina sp. "A"		X						X	X	X		X	
Glabratella australensis	X	X	X	X	X	X	X	X	X	X	X	X	X
Patellina corrugata	X	X	X	X	X	X	X	X	X	X	X	X	X
Ammonia parkinsoniana	X	X	X	X				X	X	X	X	X	X
Pararotalia nipponica	X	X	X	X		X		X	X	X	X	X	X
Elphidium advenum	X	X	X	X	X	X	X	X	X	X	X	X	X
Elphidium articulatum	X	X	X	X	X	X	X	X	X	X	X	X	X
Elphidium crispum		X	X	X		X	X	X			X	X	X
Elphidium excavatum	X		X	X	X	X	X	X	X	X	X	X	X
Elphidium macellum	X	X	X	X	X	X	X	X	X	X	X	X	X
Elphidiella sp. "A"													X
Globigerina bulloides		X											
Neogloboquadrina pachyderma	X												
Cibicides lobatulus	X	X	X	X	X	X	X	X	X	X	X	X	X
Planorbulina mediterranensis	X	X	X	X	X	X	X	X	X	X	X	X	X

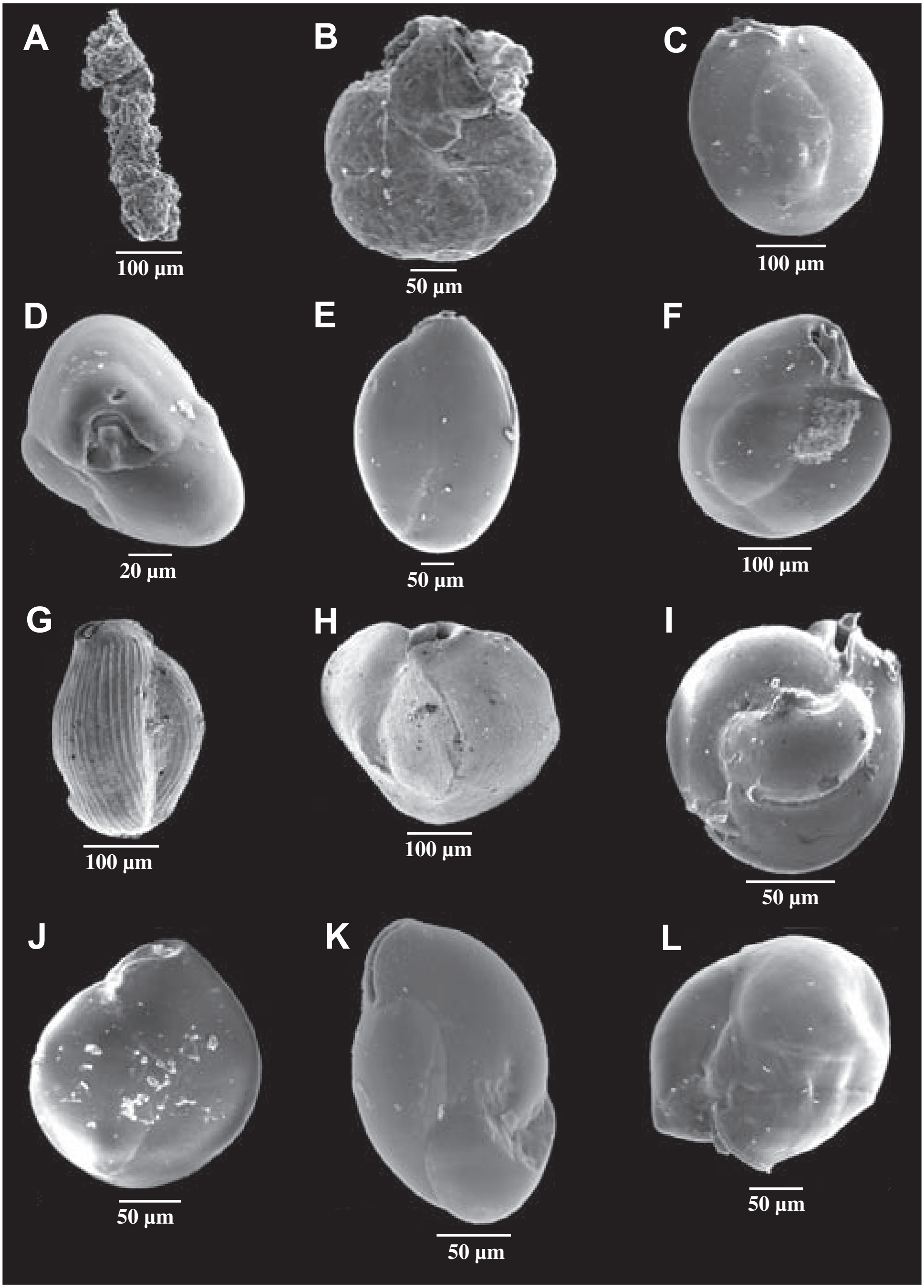
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Fig. 2 A–L: (A) *Marsipella* sp. "A"; (B) *Trochammina squamata* Jones & Parker, 1860; (C, D) *Quinqueloculina dunkerquiana* Heron-Allen & Earland, 1930; (E) *Quinqueloculina seminulum* (Linné, 1758); (F) *Quinqueloculina triangularis* d'Orbigny, 1846; (G) *Quinqueloculina undulata* d'Orbigny, 1852; (H) *Quinqueloculina vulgaris* d'Orbigny, 1826; (I) *Quinqueloculina* sp. "A"; (J) *Triloculina trigonula* (Lamarck, 1804); (K–L) *Miliolinella subrotundata* (Montagu, 1803).

Distribution: Cosmopolitan on the inner-shelf, littoral. Around South Africa found at Sea Point. Recorded by McMillan (1987) off the coast of Namibia.

Order Miliolida Delage & Hérouard, 1896

Family Hauerinidae Schwager, 1876

Quinqueloculina d'Orbigny, 1826

Quinqueloculina dunkerquiana (Heron-Allen & Earland, 1930)

Figs 2C, 2D

Miliolina dunkerquiana: Heron-Allen & Earland 1930: 123, pl. II.
Q*uinqueloculina dunkerquiana*: Haynes 1973: 4, pl. 1, fig. 8.

Material examined: A27392, A27393.

Distribution: Cosmopolitan, inner shelf, littoral. Around South Africa, found from Sea Point to Port Elizabeth. Recorded by McMillan (1987, 1990).

Quinqueloculina seminulum (Linné, 1758)

Fig. 2E

Serpula seminulum: Linné 1758: 786.
Miliolina seminulum (Linné): Heron-Allen & Earland 1930: 56.
Quinqueloculina seminula: Parker 1952, pl. 3, figs 21, 22, pl. 4, figs 1, 2; Hedley *et al.* 1967: 26; Haynes 1973: 1, 17; Loeblich & Tappan 1988: 336, pl. 344, figs 8–13, 17–22; Albani *et al.* 2001; McMillan 1990*b*: 138, figs 6G–I.

Material examined: A27394.

Distribution: Cosmopolitan, inner shelf, littoral. Around South Africa, found from Sea Point to Port Elizabeth. Also recorded by McMillan (1987*a*, 1990*b*).

Quinqueloculina triangularis d'Orbigny, 1846

Fig. 2F

Quinqueloculina triangularis: d'Orbigny 1846: 288, pl. 18, figs 7–9; Hedley *et al.* 1967: 26, 27; McMillan 1990*b*: 138, figs 5G, 5H.

Material examined: A27392.

Distribution: Cosmopolitan, inner shelf, littoral. First living record of the species for South Africa at Sea Point.

Quinqueloculina undulata d'Orbigny, 1852

Fig. 2G

Quinqueloculina undulata: d'Orbigny 1852: 195.
Miliolina undulata (d'Orbigny): Heron-Allen & Earland 1915: 573, pl. XLIII, figs 5–8; 1930: 62.
Quinqueloculina undulata: Rosset-Moulinier 1972: 140, pl. 6, figs 5–7; McMillan 1990*b*: 139, figs 5I, 7A.

Material examined: A27395.

Distribution: Cosmopolitan, littoral. Around South Africa from Sea Point to Port Elizabeth. Recorded by McMillan (1987*a*, 1990*b*). First living record of this species for South Africa.

Quinqueloculina vulgaris d'Orbigny, 1826

Fig. 2H

Quinqueloculina vulgaris: d'Orbigny 1826: 302; Heron-Allen & Earland 1915: 569; 1930: 56; Lankford & Phleger 1973: 126, pl. 2, fig. 1.

Material examined: A27396.

Distribution: Cosmopolitan, inner shelf, littoral. In South Africa, from St James to Kleinmond. First record of the species for South Africa.

Quinqueloculina sp. "A"

Fig. 2I

Description: Shape rounded. Coiling quinqueloculine. Plano-convex chamber walls, chambers inflated. Sutures depressed. Has calcareous porcelainous shell, highly polished wall and is imperforate. Width = 135 µm, height = 160 µm, width:height = 1:1.19.

Material examined: A27397.

Distribution: Sea Point, South Africa.

Remarks: *Quinqueloculina* sp. "A" has a smooth, highly polished imperforate shell and the test is round. These characters are similar to those of *Q. dunkerquiana, Q. seminulum, Q. isabellei* or *Q. triangularis*, however, all the chambers of *Quinqueloculina* sp. "A" are much more inflated and the sutures are more depressed than in all the species mentioned. The final chamber also overlaps slightly towards the aperture. Specimens were rare in the samples, and only one specimen was examined on the SEM. It was therefore difficult to determine whether this is a distinct species or merely a variation of a previously described species.

Triloculina d'Orbigny, 1826

Triloculina trigonula (Lamarck, 1804)

Fig. 2J

Miliolites trigonula: Lamarck 1804: 351, pl. 17, figs 4a–c.

Triloculina trigonula: Heron-Allen & Earland 1915: 561; Rosset-Moulinier 1972: 145, pl. 7, figs 8, 9; Haynes 1981, pl. 176, fig. 8.12; Loeblich & Tappan 1988: 344, pl. 351, figs 19–21; Hayward *et al.* 1999: 106, pl. 5, figs 31, 32; Albani *et al.* 2001.

Material examined: A27393, A27398.

Distribution: Cosmopolitan, sub-littoral to littoral. Around South Africa, from Buffels Bay to Port Elizabeth. Reported by McMillan (1987*a*) from samples off the coast of Namibia.

Miliolinella Wiesner, 1931

Miliolinella subrotundata (Montagu, 1803)

Figs 2K, 2L

Vermiculum subrotundum: Montagu 1803: 521.

Miliolinella subrotundata: Boltovskoy 1963: 63, pl. 7, figs 2, 3; Haynes 1981: 177, figs 8.12 (17/18); Hayward *et al.* 1999: 96, pl. 13, fig. 24; Albani *et al.* 2001.

Material examined: A27392, A27398.

Distribution: Cosmopolitan in shallow marine environments. Around South Africa from Sea Point to Port Elizabeth. Recorded by McMillan (1987*a*) from samples off the coast of Namibia.

Family Lagenidae Reuss, 1862

Lagena Walker & Jacob, 1798

Lagena semilineata Wright, 1886

Fig. 3A, 3B

Lagena semilineata: Wright 1886: 320, pl. 26, fig. 7; Earland 1934: 161, pl. 7, figs 19, 20; Albani *et al.* 2001.

Material examined: A27392.

Distribution: Inner shelf, littoral; Australia, Europe. Around South Africa from Kommetjie to Hermanus. Also recorded from samples off the coast of Namibia (McMillan 1987*a*).

Remarks: Differs from the Australian specimen described by Albani *et al.* (2001) in that it does not have raised costae on the test, and costae around the neck do not curve and do not extend the length of the neck. These differences in ornamentation can separate species.

Lagena sulcata Walker & Jacob, 1798

Fig. 3C

Serpula lagena striata sulcata rotundata: Walker & Boys 1784: 2, pl. 1, fig. 6.
Serpula (*Lagena*) *sulcata*: Walker & Jacob 1798: 634, pl. 14, fig. 5.
Lagena sulcata: Parker & Jones 1865: 351; Cushman 1913: 22, pl. 9, fig. 2; 1923: 57, pl. 11, fig. 1; 1933: 16.

Material examined: A27399.

Distribution: Recorded from the Pacific. Around South Africa from Sea Point to Hermanus.

Lagena tenuis (Bornemann, 1855)

Fig. 3D

Ovulina tenuis: Bornemann 1855: 317, pl. 12, figs 3a, 3b.
Lagena tenuis: Murray 1971: 89, pl. 35, figs 1, 2; McMillan 1987*a*: 209, pl. 5, figs 13–15.

Material examined: A27399.

Distribution: Cosmopolitan. Around South Africa from Sea Point to Hermanus. Recorded by McMillan (1987*a*) off the coast of Namibia.

Family Ellipsolagenidae
Lagenosolenia McCulloch, 1977
Lagenosolenia sp. “A”

Figs 3E, 3F

Description: Elongated ovate shape with definite neck region. Unilocular. Wall calcareous and hyalinated, central region perforate, pores quite large. Double keeled margin. Aperture covered by laterally flaring lip. Width = 128.5 μm, height = 275 μm, width:height = 0.47:1.

Material examined: A27399, A27400.

Distribution: Around South Africa from Buffels Bay to Victoria Bay.

Remarks: Only two species were found that were similar in structure to *Lagenosolenia* sp. “A”, *L. falcouncinata* Albani & Yassini, 1989 and *L. largicosta* Albani & Yassini, 1989. Both have a neck, which terminates in laterally flaring lips and both have raised margins or keels. However, *L. falcouncinata* has a smooth central region, unlike *Lagenosolenia* sp.“A” which has large perforations in the central region. *L. largicosta* has large central pores; however it has a wide rough margin, which extends into a thin keel. Both these species have a distinctive neck region, which is absent in *Lagenosolenia* sp. “A”. The species recovered here is therefore very different to similar species examined.

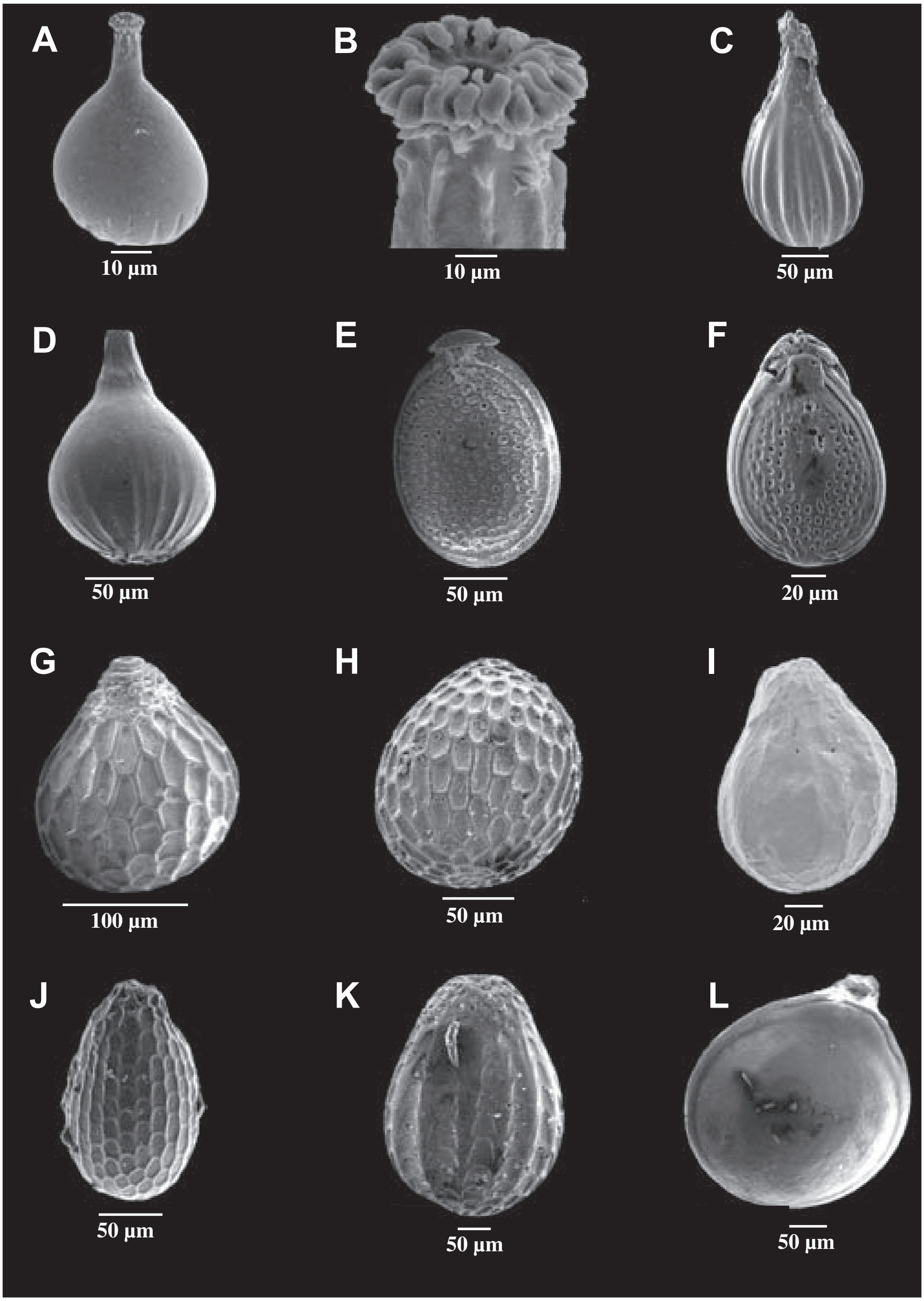
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Fig. 3 A–L: (A, B) *Lagena semilineata* Wright, 1886; (C) *Lagena sulcata* Walker & Jacob, 1798; (D) *Lagena tenuis* (Bornemann, 1855); (E, F) *Lagenosolenia* sp. "A"; (G–I) *Oolina* sp. "A"; (J) *Oolina melo* d'Orbigny, 1839; (K) *Oolina squamosulcata* (Heron-Allen & Earland, 1922); (L) *Fissurina marginata* (Montagu, 1803).

Oolina d'Orbigny, 1839
Oolina sp. "A"
Figs 3G–I

Description: Test ovoid to elongate-ovoid. Unilocular. Wall ornamented by raised rounded highly polished ribs; flat areas matt. Ribs in elongate hexagonal pattern; pattern can become irregular. Neck surrounded by subcircular ribs. Apical region has slight depression surrounded by thick, circular rib. Aperture terminal, circular to sub-circular on short dome-shaped neck. Width = 155.55 µm, height = 161.11 µm, width:height = 0.97:1.

Material examined: A27401, A27402.

Distribution: Around South Africa from Sea Point to Port Elizabeth. Also recorded off the coast of Namibia by McMillan (1987*a*).

Remarks: Similar to *O. hexagona* as described by Hayward *et al.* (1999). Differs in the ornamentation around the neck region and the lack of a narrow, distinct neck. Also differs in the irregular pattern on the test. *O. scalariformis* (Albani *et al.* 2001) also has raised longitudinal and transverse costae, however these are more square than the irregular shape of *Oolina* sp. "A". *O. melo* also has raised longitudinal and transverse costae. This species was first identified by McMillan (1987*a*) as being different; however, the species was not named as the author was not entirely sure that the species was new. Specimen shown in Fig. 3I, has similar markings and shape to *Oolina* sp. "A", and may merely be an abraded *Oolina* sp. "A" and not a separate species.

Oolina melo d'Orbigny, 1839
Fig. 3J

Oolina melo: d'Orbigny 1839*a*: 20, pl. 5, fig. 9; Boltovskoy 1963: 64, pl. 7, fig. 17; Lankford & Phleger 1973: 123, pl. 13, figs 8, 9; Hayward *et al.* 1999: 122, pl. 8, fig. 3; Albani *et al.* 2001.

Material examined: A27399.

Distribution: Cosmopolitan, inner shelf, littoral. Around South Africa from Sea Point to Hermanus. Reported by McMillan (1987*a*) from the coast of Namibia.

Remarks: This species has been widely reported by different authors. The test was more elongated and the costae were not as well-defined compared to the specimen illustrated by Hayward *et al.* (1999). The specimen is very similar to the species illustrated by Albani *et al.* (2001).

Oolina squamosulcata (Heron-Allen & Earland, 1922)
Fig. 3K

Lagena squamoso-sulcata: Heron-Allen & Earland 1922: 151, pl. 5, figs 15, 19.
Oolina squamoso-sulcata: Loeblich & Tappan 1953: 74, pl. 12, figs 6, 7; McMillan 1990*b*: 144, figs 8C, 8D.

Material examined: A27400.

Distribution: Cosmopolitan, inner shelf, littoral. Around South Africa from Buffels Bay to Pringle Bay. First living specimen recorded in South Africa.

Fissurina Reuss, 1850
Fissurina marginata (Montagu, 1803)
Figs 3L, 4A

Vermiculum marginatum: Montagu 1803: 524.
Fissurina marginata: Boltovskoy 1959: 69, pl. 9, fig. 18. Hayward *et al.* 1999: 119, pl. 7, figs 22, 23; McMillan 1990*b*: 144, figs F, G; Dale & McMillan 1999, pl. 29, figs 2, 3.

Material examined: A27403, A27404.

Distribution: Cosmopolitan, inner shelf, littoral. Around South Africa from Sea Point to Port Elizabeth.

Remarks: Differs from that described by Hayward *et al.* (1999) in that the keel is not as distinctive but is quite narrow.

Fissurina sp. "A"
Figs 4B, 4C

Material examined: A27405, A27406.

Distribution: Around South Africa from Buffels Bay to Port Elizabeth.

Remarks: Species differs from *F. marginata* due to the presence of a double keel and a distinctive short neck. *F. orbignyana* Seguenza described by Hayward *et al.* (1999) has a similar shape to *Fissurina* sp. "A"; however, it differs in that the neck region is less distinctive and there is a spine on the aboral end. *F. claricurta* McCulloch also has a double keel; however, it does not have a distinct neck region and the secondary keel is not as distinctive as in *Fissurina* sp. "A". *Lagenosolenia bradii* (Silvestri) (Albani *et al.* 2001) is similar to this species in that it has a double keel and a distinctive neck region; however it differs from *Fissurina* sp. "A" in that it has an aboral spine. *L. bradii* (Silvestri) is however, the most similar to this species than any other *Fissurina* species examined.

Family Polymorphinidae d'Orbigny, 1839
Guttulina d'Orbigny, 1839
Guttulina irregularis (d'Orbigny, 1846)
Fig. 4D

Globulina irregularis: d' Orbigny 1846: 226, pl. 13, figs 9, 10.
Guttulina irregularis: Cushman & Ozawa 1930: 25, pl. 3, figs 3, 4, pl. 7, figs 1, 2; Hayward *et al.* 1999: 117, pl. 7, figs 10, 11; Albani *et al.* 2001.

Material examined: A27392.

Distribution: West Pacific; around South Africa, Sea Point. First record of the species for South Africa.

Family Glandulinidae Reuss, 1860
Glandulina d'Orbigny, 1839
Glandulina sp. "A"
Fig. 4E

Description: Circular test. Raised costae on the lower half of the test and around the aperture. Width = 193.75 µm, height = 196.88 µm, width:height = 0.98:1.

Material examined: A27400.

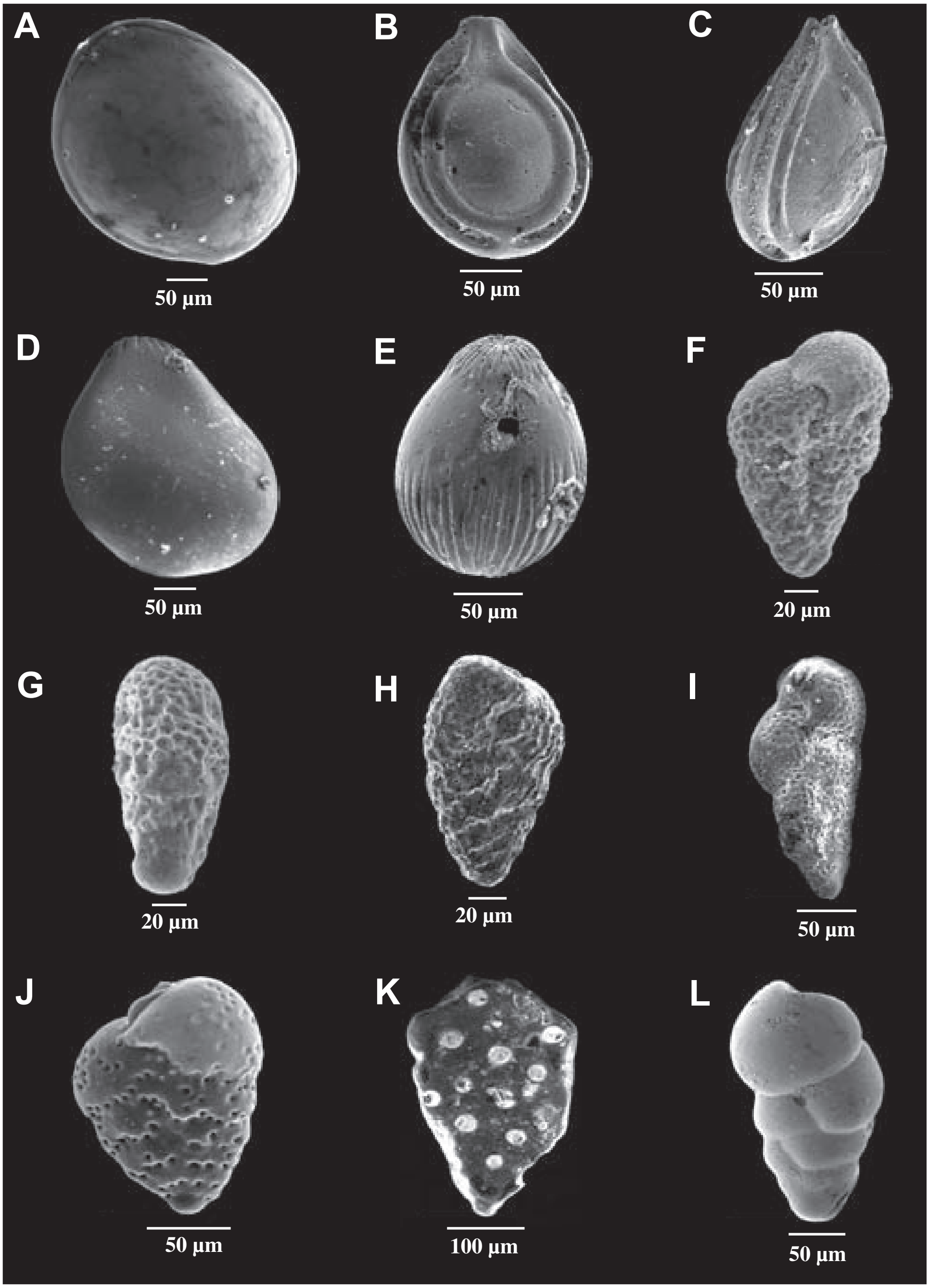
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Fig. 4 A–L: (A*) Fissurina marginata* (Montagu, 1803); (B, C) *Fissurina* sp. "A"; (D) *Guttulina irregularis* (d'Orbigny, 1846); (E) *Glandulina* sp. "A"; (F) *Bolivina* "*fossa*" McMillan, 1987 m.s.; (G, H) *Bolivina pseudoplicata* Heron-Allen & Earland, 1930; (I) *Bolivina* sp. "A"; (J) *Brizalina pseudopunctata* (Höglund, 1947); (K) *Brizalina* "*rocklandsensis*" McMillan, 1987 m.s.; (L) *Bulimina elongata* d'Orbigny, 1846.

Distribution: Around South Africa from Sea Point to Port Elizabeth.

Remarks: The only other specimen of *Glandulina* examined was *G. antarctica.* This species has an elliptical test shape whereas the species examined here has a round shape. No ornamentation was present on the test or around the aperture as in *Glandulina* sp. "A".

Family Bolivinidae Cushman, 1927

Bolivina d'Orbigny, 1839

Bolivina "*fossa*" McMillan, 1987

Fig. 4F

Bolivina "*fossa*": McMillan 1987*a*: 285–286, pl. 10, figs 9–13.

Description: Test slightly compressed, increasing in width in early part of test, becoming almost parallel-sided, maximum width at final chambers. Wall has moderate to coarse perforations. Periphery broadly rounded with outline irregular, becoming lobate near final chambers. Chambers arranged biserially. Sutures initially indistinct becoming distinct and depressed. Aperture sub-terminal, narrow and elongate-ovate shape. Channel-like depression from proloculus to final pair of chambers. Width = 73.33 µm, height = 120 µm, width:height = 0.61:1.

Material examined: A27392.

Distribution: Around South Africa from Sea Point to Port Elizabeth. This species was first described and named by McMillan (1987*a*) from samples retrieved off the coast of Namibia.

Bolivina pseudoplicata Heron-Allen and Earland, 1930

Figs 4G, 4H

Bolivina plicata sensu Brady 1870: 302, pl. 12, figs 7a, 7b.

Bolivina pseudoplicata: Heron-Allen & Earland 1930: 81, pl. 3, figs 36–40; Boltovskoy 1963: 60, pl. 6, fig. 4; Hedley *et al.* 1967: 30, pl. 9, figs 4A, 4B; Hayward *et al.* 1999: 126, pl. 8, figs 14, 15; Albani *et al.* 2001.

Material examined: A27392, A27391.

Distribution: Typical of inner shelf to littoral environments. Around South Africa from Sea Point to Port Elizabeth. Recorded by McMillan (1987*a*) from samples off the coast of Namibia.

Bolivina sp. "A"

Fig. 4I

Description: Triangular appearance. Depressed sutures. Wall has small pores and larger pores along sutures. Aperture is terminal. Width = 80 µm, height = 150 µm, width:height = 0.53:1.

Material examined: A27398, A27399.

Distribution: Around South Africa, Sea Point.

Remarks: *Bolivina* sp. "A" lacks the coarse perforations found on *B.* "*fossa*", which also has sutures that are initially indistinct, becoming distinct towards the final chambers, whereas *Bolivina* sp. "A" has sutures which are quite distinct. *Bolivina* sp. "A" also differs from *B. pseudoplicata* which has strong excavations and ornamentations especially near the midline. *Bolivina* sp. "A" has a similar triangular shape to *B. compacta* and the wall is coarsely perforate, however, the pores are much larger and less dense and the sutures are more distinct than in *Bolivina* sp. "A".

Brizalina Costa, 1856

Brizalina pseudopunctata (Höglund, 1947)

Fig. 4J

Bolivina pseudopunctata: Höglund 1947: 273, pl. 24, figs 5a, 5b.

Brizalina pseudopunctata: Parker 1952: pl. 5, figs 20, 21; Murray 1970: 484, pl. 1, figs 15, 16; Dale & McMillan 1999: 63, pl. 28, fig. 1.

Material examined: A27399, A27407, A27393.

Distribution: Cosmopolitan, innershelf, littoral. Around South Africa from Sea Point to Port Elizabeth. Recorded off the west coast of South Africa by Dale and McMillan (1998).

Brizalina "*rocklandsensis*" McMillan, 1987

Fig. 4K

Brizalina "*rocklandsensis*": McMillan 1987*a*: 299, pl. 11, figs 3–9.

Description: Test initially weakly compressed becoming strongly compressed in final part. Test increases rapidly in width in early part, maximum width in final chambers. Periphery rounded becoming sub-acute. Elongate and tapering strongly. Smooth wall with very large pores, not appearing to be arranged in a particular way. Aperture is terminal. Width = 250 µm, height = 362.5 µm, width:height = 0.69:1.

Material examined: A27408.

Distribution: Around South Africa from St James to Port Elizabeth. This species was first examined and described by McMillan (1987*a*) from vibracores retrieved off the coast of Namibia.

Bulimina elongata d' Orbigny, 1846

Fig. 4L

Bulimina elongata: d'Orbigny 1846: 187, pl. 11, figs 19, 20; Cushman 1911: 79, figs 131a–d; Rosset-Moulinier 1972: 163, pl. 9, fig. 18; Hayward *et al.* 1999: 132, pl. 9, figs 6, 7.

Material examined: A27409.

Distribution: Cosmopolitan. Around South Africa from Sea Point to Port Elizabeth. Recorded by McMillan (1987*a*) from samples off the coast of Namibia.

Family Uvigerinidae Haeckel, 1894

Trifarina Cushman, 1923

Trifarina angulosa (Williamson, 1858)

Fig. 5A

Uvigerina angulosa: Williamson 1858: 67, pl. V, fig. 140.

Angulogerina angulosa: Parker 1952: 413, pl. 5, figs 18, 19.

Trifarina angulosa: Loeblich & Tappan 1964: 571, fig. 450, 1a, 1b, 2a, 2b, 3; Rosset-Moulinier 1972: 164, pl. 9, fig. 23; McMillan 1990*b*: 145, figs 10A, 10B; Hayward *et al.* 1999: 134, pl. 9, figs 23, 24.

Material examined: A27410.

Distribution: Cosmopolitan on the inner-shelf, littoral. Around South Africa, Sea Point. Recorded by McMillan (1987*a*, 1990*b*).

Family Rosalinidae Reiss, 1963

Neoconorbina Hofker, 1951

Neoconorbina sp. "A"

Fig. 5B

Description: Test round, trochsospiral. Early chambers subglobular, increasing in breadth, final chamber extends almost half periphery. Radial sutures raised and curved, suture of final chamber almost completely horizontal. Wall finely perforate. Width = 124 µm, height = 150 µm, width:height = 0.83:1.

Material examined: A27411.

Distribution: Around South Africa from St James to Port Elizabeth.

Remarks: The identification of this specimen as *Neoconorbina* is not entirely certain; it may also be *Gavelinopsis* sp. or *Pileolina* sp. All three of these genera have chambers which enlarge as they are added, so that the final sutures become strongly oblique. *Gavelinopsis hamatus* (Hayward *et al.* 1999) has an umbilical plug and is finely perforate whereas *Neoconorbina* sp. "A" has enlarged dense pores on the central chambers. *Neoconorbina terquemi* (Hayward *et al.* 1999) is smooth to finely perforate, lacking rows of large pores or papillae. *Pileolina zealandica* (Hayward *et al.* 1999) has a flat umbilical side with strong central tubercles with numerous branching striae towards the periphery; it is more finely perforate than *Neoconorbina* sp. "A".

Rosalina d'Orbigny, 1826

Rosalina cf. *globularis* d'Orbigny, 1826

Figs 5C, 5D

Rosalina globularis: d'Orbigny 1826: 271, pl. 13, figs 1–4; Loeblich & Tappan 1988: 561, pl. 610, figs 1–5, pl. 611, figs 1–6, fig. 459, 1a–c; Levy *et al.* 1979: 78, pl. 4, figs 41, 44, 45; McMillan 1987*a*: 348, pl. 13, figs 14–18.

Description: Rounded to lobate shape. Dorsal side convex while ventral side flat and slightly concave. Test smooth with prominent coarse perforations. Dorsal view finely perforate with almost smooth central region. Large pores on ventral side, absent near periphery. Chambers strongly inflated on dorsal side. Radial sutures on dorsal side curved towards periphery. Aperture interio-marginal on ventral side. Aperture elongated, extending from periphery to umbilicus. Umbilicus wide and deep, partially obscured by umbilical flaps.Width = 138 µm, height = 116 µm, width:height = 1.19:1.

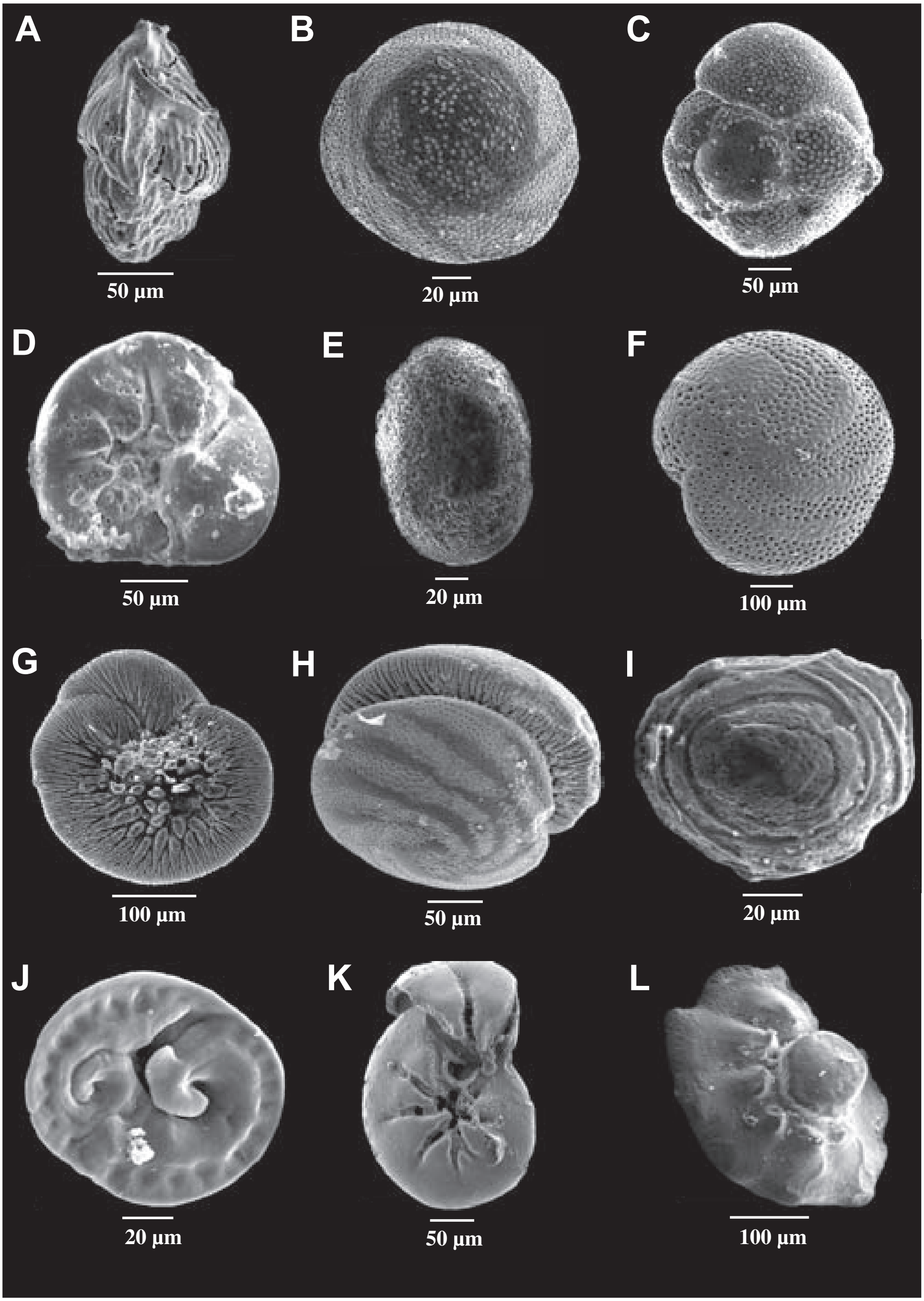
Material examined: A27411, A27398, A27412.

Distribution: Widespread in shallow marine environments. Around South Africa from Sea Point to Port Elizabeth. Recorded by McMillan (1987*a*) off the coast of Namibia.

Rosalina sp. "A"

Fig. 5E

Description: Rounded. No chambers visible on dorsal side, ventral side unknown. Margin rounded but not regular. Finely perforate with depressed areas. Width = 140 µm, height = 145 µm, width:height = 1:1.03.


A
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B
20 µm
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50 µm
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50 µm
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F
100 µm
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50 µm
I
20 µm
J
20 µm
K
50 µm
L
100 µm

Fig. 5 A–L: (A) *Trifarina angulosa* (Williamson, 1858); (B) *Neoconcorbina* sp. "A"; (C, D) *Rosalina* cf. *globularis* d'Orbigny, 1826; (E) *Rosalina* sp. "A"; (F–H) *Glabratella australensis* (Heron-Allen & Earland, 1932); (I, J) *Patellina corrugata* Williamson, 1858; (K) *Ammonia parkinsoniana* (d'Orbigny, 1839); (L) *Pararotalia nipponica* (Asano, 1936).

Material examined: A27413.

Distribution: Around South Africa from Kommetjie to Victoria Bay.

Remarks: Differs from *Rosalina globularis,* which has coarse perforations and inflated chambers which give the test a lobate shape. It also has distinct curved radial sutures absent in *Rosalina* sp. "A". *R. bradyi* has flush limbate sutures and dorsal perforations which disappear towards the periphery, differing from *Rosalina* sp. "A". *R. irregularis* has irregular chambers which are longer than wide with each successive whorl. The position of chambers is uncertain because of the lack of distinct sutures. This species could possibly be *Glabratellina kermadecensis* (Hayward *et al.* 1999) as both these species have coarsely perforate test walls which obscure chamber arrangements and sutures.

Family Glabratellidae Loeblich & Tappan, 1964
Glabratella Dorreen, 1948
Glabratella australensis (Heron-Allen & Earland, 1932)

Figs 5F, 5H

Discorbis australensis: Heron-Allen & Earland 1932: 416.
Pileolina australensis: Barker 1960: 184, pl. 89, figs 2–4.
Glabratella australensis: Albani 1979: 38, fig. 76.1; McMillan 1987*a*: 363, figs 14–18, pl. 15, figs 2–4; Lankford & Phleger 1973: 121, pl. 4, fig. 26; Albani *et al.* 2001.

Material examined: A27392, A27414, A27415.

Distribution: Australia, also reported off the west coast of North America. Around South Africa from Sea Point to Port Elizabeth. Reported by McMillan (1987*a*) from samples collected off the coast of Namibia.

Remarks: Differs from the specimen illustrated by Albani *et al.* (2001) in that the shape is more lobulate and surface is more perforate. The South African species of *G. australensis* differs from that of the Australian and N. American species in the shape of the shell.

Family Patellinidae Rhumbler, 1906
Patellina Williamson, 1858
Patellina corrugata Williamson, 1858

Figs 5I, 5J

Patellina corrugata: Williamson 1858: 46, pl. 3, figs 86–89; Cushman 1930: 15, pl. 3, figs 5a–c; Hedley *et al*. 1967: 46; Boltovskoy & Lena 1966: 147, 148, pl. 13, fig. 15; Hayward *et al*. 1999: 93, pl. 3, figs 11–13; Albani *et al*. 2001.

Material examined: A27416, A27417.

Distribution: Cosmopolitan, littoral and sub-littoral environments. Around South Africa from Sea Point to Port Elizabeth. Recorded by McMillan (1987*a*) from samples retrieved off the coast of Namibia.

Remarks: Species widely reported by many authors. Differs from that described by Hayward *et al*. (1999) in that tests are more compressed.

Family Rotaliidae Ehrenberg, 1839
Ammonia Brünnich, 1772
Ammonia parkinsoniana (d'Orbigny, 1839)
Fig. 5K

Rosalina parkinsoniana: d'Orbigny 1839*b*: 99, pl. 4, figs 25–27.
Ammonia parkinsoniana: Poag 1978: 397, pl. 1, figs 1–21; Boltovskoy 1970: 338; McMillan 1987*a*: 439, pl. 20, figs 6–12; Hayward *et al.* 1999: 162, pl. 16; Dale & McMillan 1999, pl. 27, figs 2–7.

Material examined: A27418.

Distribution: Cosmopolitan; hyposaline, estuarine and inner shelf environments. Around South Africa from Sea Point to Port Elizabeth. Recorded by McMillan (1987*a*) from the coast of Namibia and by Dale and McMillan (1999) from the west coast of South Africa.

Remarks: May be similar to *Ammonia parkinsoniana* f. *aoteana* (Finlay, 1940) as described by Hayward *et al.* (1999); however a view of the dorsal side was not obtained.

Pararotalia Le Calvez, 1949
Pararotalia nipponica (Asano, 1936)
Figs 5L, 6A, 6B

Calcarina rotula sensu Chapman 1923: 3, pl. 1, fig. 1.
Rotalia nipponica: Asano 1936: 614, pl. 31, figs 2a–c.
Pararotalia nipponica: Ujiié 1966: 192, pl. 24, figs 1–7, pl. 25, figs 1–5; McMillan 1987*a*: 443, pl. 20, figs 13–17, pl. 21, figs 1–3; 1990*b*: 170, figs 17A–C; Kitazato 1988: 824, pl. 11, figs 1–4; Dale & McMillan 1999: 18, pl. 2, figs 5–8.

Material examined: A27419, A27420, A27421, A27414.

Distribution: Inner shelf, littoral. Indo-Pacific and off the east coast of the Atlantic. Around South Africa from Sea Point to Port Elizabeth. Recorded by McMillan (1987*a*) from the coast of Namibia and by Dale and McMillan (1999) from the west coast of South Africa.

Remarks: Tests vary greatly morphologically, chambers can have well defined sutures, be smooth or spined and sutures and umbilical plug on the umbilical side can also be well-defined or smooth.

Family Elphidiidae Galloway, 1933
Elphidium de Montfort, 1808
Elphidium advenum (Cushman, 1922)
Fig. 6C

Polystomella advena: Cushman 1922: 56, pl. 9, figs 11, 12.
Elphidium advenum: Cushman 1930: 25, pl. 10, figs 1, 2; Haynes 1981, pl. 8; Hayward *et al.* 1997: 64; Dale & McMillan 1999: 63, pl. 28, fig. 4; Albani *et al.* 2001.

Material examined: A27422.

Distribution: Inner to outer shelf. Pacific, Indian and western Atlantic Oceans. Around South Africa from Sea Point to Port Elizabeth. Recorded by McMillan (1987*a*) from the coast of Namibia and by Dale and McMillan (1999) from the west coast of South Africa.

Elphidium articulatum (d'Orbigny, 1839)

Fig. 6D

Polystomella articulata: d'Orbigny 1839*a*: 30, pl. 3, figs 9, 10.
Elphidium articulatum: Cushman 1930: 26, pl. 10, figs 6–8; Parker 1952: 411, pl. 5, figs 5–7; Boltovskoy 1963, pl. 6, fig. 15; McMillan 1990*b*: 159, figs 15B, 15C; Dale & McMillan 1999, pl. 28, figs 5, 6.

Material examined: A27423.

Distribution: From Indian and Atlantic Oceans; no reports from the Pacific. Around South Africa from Sea Point to Port Elizabeth. Recorded by McMillan (1987*a*, 1990*b*) from the coast of Namibia and by Dale and McMillan (1999) from the west coast of South Africa.

Elphidium crispum (Linné, 1758)

Fig. 6E

Nautilus crispus: Linné 1758: 709.
Polystomella crispa (Linné): Brady 1884: 736, pl. 110, figs 6, 7.
Elphidium crispum: Heron-Allen & Earland 1915: 733; Haynes 1981: 272, fig. 12.9 (22/23); Kitazato 1988: pl. 11, figs 8, 9; McMillan 1990*b*: 161, figs 15D, 15E; Hayward *et al*. 1997: 74; Albani *et al*. 2001.

Material examined: A27421, A27423.

Distribution: Inner shelf to littoral. Indo-Pacific and Mediterranean. Around South Africa from Kommetjie to Port Elizabeth. Recorded by McMillan (1987*a*) from the coast of Namibia and by Dale and McMillan (1999) from the west coast of South Africa.

Elphidium excavatum (Terquem, 1875)

Fig. 6F

Polystomella excavata: Terquem 1875: 25, pl. 2, figs 2a–f.
Elphidium excavatum: Feyling-Hanssen 1972: 339–344, pl. 1–6; Hayward *et al*. 1997: 76, pl. 8, figs 14–17, pl. 9, figs 1–8.

Material examined: A27407.

Distribution: Cosmopolitan. Around South Africa from Sea Point to Port Elizabeth. Recorded by McMillan (1987*a*) from the coast of Namibia and by Dale and McMillan (1999) from the west coast of South Africa.

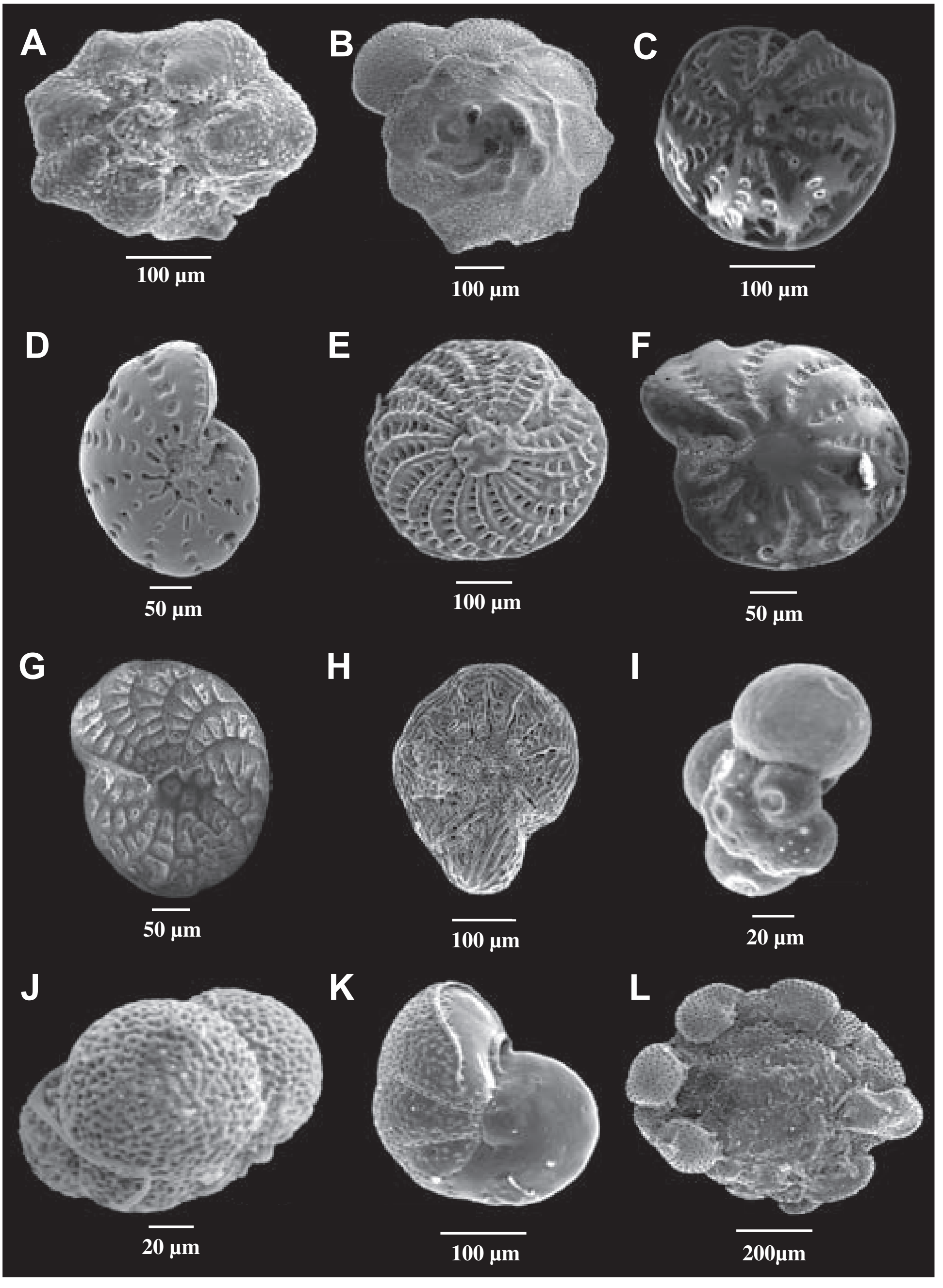
Elphidium macellum (Fichtel & Moll, 1798)

Fig. 6G

Nautilus macellus varietas ß: Fichtel & Moll 1798: 66, pl. 10, figs h–k.
Elphidium macellum: Cushman 1939: 51, pl. 14, figs 1–3; Heron-Allen & Earland 1915: 734; Boltovskoy 1963: 62, pl. 6, fig. 16; Brasier 1975: 199, pl. 1, fig. 7; Hayward *et al*. 1997: 84, pl. 13, figs 9–14.

Material examined: A27421.

Distribution: Indo-Pacific and Mediterranean. Around South Africa from Sea Point to Port Elizabeth. Recorded by McMillan (1987*a*) from the coast of Namibia and by Dale and McMillan (1999) from the west coast of South Africa.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K
100 µm
L
200µm

Fig. 6 A–L: (A, B) *Pararotalia nipponica* (Asano, 1936); (C) *Elphidium advenum* (Cushman, 1922); (D) *Elphidium articulatum* (d'Orbigny, 1839); (E) *Elphidium crispum* (Linné, 1758); (F) *Elphidium excavatum* (Terquem, 1875); (G) *Elphidium macellum* (Fichtel & Moll, 1798); (H) *Elphidiella* sp. "A"; (I) *Globigerina bulloides* d'Orbigny, 1826; (J) *Neogloboquadrina pachyderma* (Ehrenberg, 1861); (K) *Cibicides lobatulus* (Walker & Jacob, 1798); (L) *Planorbulina mediterranensis* d'Orbigny, 1826.

Elphidiella Cushman, 1936
Elphidiella sp. "A"

Fig. 6H

Description: Rounded test, involute. Chambers inverted v-shape. Raised radial sutures with raised septal bridges. Sutures on final chamber do not radiate from the centre but are peripheral. Pores along radial sutures. Umbilicus with many papillae. Marginal aperture. Width = 375 µm, height = 375 µm, width:height = 1:1.

Material examined: A27424.

Distribution: Around South Africa, Port Elizabeth.

Remarks: Similar to a species of *Elphidiella* examined by Dale and McMillan (1999) retrieved in the Saldanha Bay region off the west coast of South Africa.

Family Globigerinidae Carpenter, Parker & Jones, 1862
Globigerina d'Orbigny, 1826
Globigerina bulloides d'Orbigny, 1826

Fig. 6I

Globigerina bulloides: d'Orbigny 1826: 277, pl. 17; Cushman 1914: 6, pl. 2, figs 7–9; Bé *et al*. 1971: 38, pl. 1, fig. 4; Cifelli 1982: 7, pl. 8, figs 1, 2, pl. 9; Kemle-von Mücke & Hemleben 1999: 61, fig. 6.3.

Material examined: A27425.

Distribution: Cosmopolitan. Abundant in subpolar and temperate waters. Around South Africa, Kommetjie. Recorded by McMillan (1987*a*) from the coast of Namibia and by Dale and McMillan (1999) from the west coast of South Africa.

Neogloboquadrina Bandy, Frerichs and Vincent, 1967
Neogloboquadrina pachyderma (Ehrenberg, 1861)

Fig. 6J

Aristerospira pachyderma: Ehrenberg 1861: 303.
Globigerina pachyderma: Bé 1960: 64–68.
Globoquadrina pachyderma: Cifelli 1982: 9, pl. 12, figs 2, 3.
Neogloboquadrina pachyderma: Kemle-von Mücke & Hemleben 1999: 66, fig. 6.27; Dale & McMillan 1999: 65, pl. 30, fig. 1.

Material examined: A27426.

Distribution: This species is nearly restricted to polar water masses, and is often the only planktic species in Antarctic and Arctic waters. Around South Africa, Sea Point. Recorded by McMillan (1987*a*) from the coast of Namibia and by Dale and McMillan (1999) and Rogers and Bremner (1991) from the west coast of South Africa.

Family Cibicididae Cushman, 1927
Cibicides de Montfort, 1808
Cibicides lobatulus (Walker & Jacob, 1798)

Fig. 6K

Nautilus lobatulus: Walker & Jacob 1798: 642, pl. 14, fig. 36.
Cibicides lobatulus: Cushman 1931: 118, pl. 21, figs 3a–c; 1959: 551, pl. 36, fig. 11; Parker 1952: fig. 26; Rosset-Moulinier 1972: 181, pl. 11, figs 9, 10; Haynes 1981: 268, figs 8–10.

Material examined A27423.

Distribution: Cosmopolitan. Shelf to littoral. Around South Africa from Sea Point to Port Elizabeth. Recorded by McMillan (1987*a*) from the coast of Namibia and by Dale and McMillan (1999) from the west coast of South Africa.

Family Planorbulinidae Schwager, 1877
Planorbulina d'Orbigny, 1826
Planorbulina mediterranensis d'Orbigny, 1826
Fig. 6L

Planorbulina mediterranensis: d'Orbigny 1826: 280, pl. 14, figs 4–6; Cushman 1959: 552, pl. 37, figs 1, 2; Cifelli & Smith 1970: 42; Brasier 1975: pl. 1, fig. 5; Albani *et al*. 2001.

Material examined: A27423, A27427.

Distribution: Cosmopolitan. Inner shelf to littoral. Around South Africa from Sea Point to Port Elizabeth. Recorded by McMillan (1987*a*) from the coast of Namibia and by Dale and McMillan (1999) from the west coast of South Africa.

Remarks: Wide variation in shape and number and arrangement of chambers in specimens.

DISCUSSION

Species found in large numbers were *Glabratella australensis, Cibicides lobatulus, Miliolinella subrotundata, Pararotalia nipponica, Patellina corrugata* and *Ammonia parkinsoniana*. These species are typically phytal, and are normally found attached to substrates (Murray 1991). *Pararotalia nipponica*, although common, is not typically attached and is considered an epifaunal species (Murray 1991). The species present indicate that foraminifera on *G. pristoides* were not only attached to the alga but were also present in the sediment trapped at the base. All of these species, with the exception of *M. subrotundata*, have flat discoid tests with broad umbilical areas for strong attachment in a wave-exposed environment (Kitazato 1988). Most of these species or genera have been reported from intertidal studies of phytal communities in Argentina (Boltovskoy *et al.* 1976), New Zealand (Hedley *et al*. 1967), Japan (Kitazato 1988) and Wales (Atkinson 1969).

The species that were found in large numbers were generally ubiquitous in their distribution around the coast (*G. australensis*, *P. nipponica*, *A. parkinsoniana* and *P. corrugata*).

There were only two agglutinated species recovered (*Marsipella* sp. "A" and *Trochammina squamata*), indicative of a well-oxygenated environment with no build-up of oceanic debris. Two planktonic species were found (*Neogloboquadrina pachyderma* and *Globigerina bulloides*), an indication of little settling in a high-energy environment. No hyposaline species were present as the sites sampled are not influenced by fresh water run-off. Taxa such as *Bolivina*, *Brizalina*, *Lagena*, *Glandulina* and *Oolina* were rare in samples and were found only in one site or in one sample. These are mostly unilocular genera, which are not typical of wave-exposed environments. Similar results were obtained in a study by Boltovskoy *et al*. (1976) in the littoral zone in Argentina.

Although there were genera, for example *Globigerina*, *Globulina*, *Neogloboquadrina* and *Trochammina*, which were present only on the two west coast shores, they were very rare. Most species were present in the Port Elizabeth samples. They were dominated by the miliolids which are most abundant in shallow warm water and coral reef regions (Cushman 1959). The dominance of these types may be an indication of the warmer water temperature at Port Elizabeth.

Using the ecological data provided by Murray (1991), it was found that none of the species recovered are true cold or warm water species. The study area experiences water temperature fluctuations throughout the year. Summer upwelling along the west coast can cause water temperatures as low as 9°C, while a periodic inflow of warm water from the Agulhas Current sometimes takes place (Branch & Griffiths 1988). False Bay is generally warm; this is caused by warm surface water from the Agulhas Current, which drifts into False Bay (Day 1970). False Bay may be subject to local upwelling in summer and cold water sometimes enters the bay (Day 1970). The warm temperate south coast has a stable temperature in winter (15–18°C), but in summer it can be highly variable (10–25°C) (Brown & Jarman 1978). Organisms living in these areas would have to be able to tolerate these fluctuations in temperature and would therefore be likely to be eurythermal.

The genera and some species found were consistent with many species found in the littoral in other parts of the world. However, this is the first study on foraminifera in this zone and it is expected that it will provide opportunity for further study, and that the list of species will grow.

ACKNOWLEDGEMENTS

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